

Title: Fourth Semi-Annual Progress Report

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Name of Project: A Program to Support the Development of Research  
in Space Science at Montana State University

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## Introduction

This report summarizes work carried on during the fourth six months of the above grant.

During the period of this report, conversations were held with members of other departments on campus with a view to extending this grant to support work in these departments. Research problems were identified in the departments of Electrical Engineering, Chemistry, and Botany and Bacteriology which should be of interest to NASA and which had the potential to develop into viable research projects. These projects were outlined in the renewal proposal dated February 15, 1965.

In the third semi-annual report dated January 19, 1965, it was mentioned that two research programs whose development was assisted by this grant had obtained independent support from other agencies. It is a pleasure to report that during the period covered by the present progress report that two more staff members, Dr. Drumheller and Dr. Caughlan, have obtained project-type support for their research programs. The details will be given below.

The quantity and quality of graduate applications continued to improve and it appears that there will be approximately 18 graduate students in physics enrolled during the 1965-66 academic year. Two of these students will be supported by NASA Graduate Traineeships.

## Work In Progress

Dr. David K. Anderson is continuing his research project to measure atomic lifetimes by the resonance fluorescence method (Hanle effect). A paper was published on earlier work: "Lifetimes of the  $(5p^26s) ^1P_1$  and  $^3P_1$  States of Xenon", Physical Review 137, A21 (1965). The first problem to be investigated in the present program is the lifetimes of the  $^1P_1$  and  $^3P_1(4p^55s)$  states of Krypton. Further work is planned on Xenon, with particular attention to the lifetimes of some of the states belonging to the  $(5p^55d)$  configuration. Construction of the gas handling system is proceeding, and a pulsed 2450 mc magnetron oscillator has been purchased and put into operation.

Dr. Joseph A. Ball and a graduate assistant have continued theoretical work on the investigation of atomic collision processes. A computer calculation was made of the total ionization to be expected in the collision of two neutral Thomas-Fermi atoms. The results to date have been rather inconclusive and various sources of the difficulty are being investigated. No publishable results have been obtained as yet.

Dr. G. R. Caughlan has been continuing work on a study of the three classes of red-giant stars: K-M, S, and C stars to see if it is possible to develop a sensible theory regarding an evolutionary sequence among such stars. This problem is now being set up for the computer. One paper was published during the period of this report: "Approach to Equilibrium in the C-N-O Bi-Cycle", Astrophysical Journal 141, 688 (1965). This paper was

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also published in somewhat greater detail as a technical report by NASA. Work is also continuing on the fast CN cycle in stars in collaboration with Professor William A. Fowler of the California Institute of Technology. A proposal for the continuing support of this work was prepared and submitted to several agencies. The proposal was accepted by the National Science Foundation and funded for \$11,700 for a period of one year starting June 1, 1965.

Dr. Irving E. Dayton has continued experimental research on excitation of atoms and molecules by electron and ion impact. The 150-keV accelerator and associated instrumentation is now complete with an electrostatic quadrupole lens and a beam analyzing magnet. The system performs very well, giving a beam of 30 microamps of analyzed protons, and it appears that this could probably be increased by a factor of ten by careful adjustment of the accelerator. A bombardment chamber has been constructed, and a graduate student is now taking preliminary data on the excitation of nitrogen by proton bombardment. A vacuum monochromator is on order and the intent is to extend measurements into the vacuum ultraviolet. Practically no excitation experiments have been carried on in this region, but it is obviously very important for a complete understanding of processes taking place in the upper atmosphere.

Dr. John E. Drumheller has continued the design and assembly of an X-band superheterodyne electron paramagnetic resonance spectrometer. The principal components completed in this six-month period were the klystron locking system phase locked detector, special power supplies for the I-f strip and microwave mixer, and some of the actual microwave assembly at the end station. A cylindrical reflection cavity operating in a  $TE_{011}$  mode has been built with a measured unloaded Q of about 8500. A proposal for the continuing support of this work was prepared and submitted to several agencies. The proposal was accepted by the National Science Foundation and funded for \$46,800 for a period of two years.

Dr. Dong-Yun Kim continued his theoretical research on positron annihilation in solids. In addition, he collaborated with Dr. V. Hugo Schmidt on a theoretical analysis of proton mobility in solids. A paper on this subject is now in preparation. In June Dr. Kim left for a post at the University of Saskatchewan in Regina.

Dr. N. MacGregor Rugheimer has been constructing apparatus for his research work on superconducting thin films. Several modifications have been planned for the apparatus so that the equipment will be more versatile than originally planned. Neither the tunneling nor the microwave apparatus is complete at the present time. Work on the computer program to aid data reduction and the comparison of theory and experiment is in progress.

### New Research Programs

Dr. Kenneth L. Nordtvedt, who is presently a Junior Fellow at Harvard University, will join the department in September 1965. Dr. Nordtvedt has been working on the many-body problem with particular application to solid-state physics. He has also worked on problems in space navigation at the M.I.T. Instrumentation Laboratory. On March 10, 1965, he submitted a proposal to NASA entitled "Back-Up Manual Space Navigation" to continue this work at Montana State University.